

THE PHILIPPINE AGRICULTURIST

JOURNAL OF THE COLLEGE OF AGRICULTURE
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The Philippine Agriculturist

Journal of the College of Agriculture and Central Experiment Station
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PROBLEMS OF SUPPORTING PRICES OF FARM PRODUCTS ¹

P. R. SANDOVAL and G. W. HEDLUND

When a country embarks on a program of supporting the price of a farm product it must be dissatisfied with price as it exists. In other words, it has a purpose which it expects to accomplish by raising prices. Usually this purpose is to increase domestic production so that the country will import less, or to increase the income of farmers, or both.

Thus, the purpose of the price support programs of many of the food-deficit countries of Europe is to increase domestic production even though food will cost consumers more than without the programs. By this procedure England is more nearly self-sufficient in food than before the war, and food costs consumers more than if the food was imported. This is true in many European countries.

On the other hand, the price support programs in the United States are largely for the purpose of raising farmers' incomes. The higher prices have another effect, namely, production increases as is observed in food-deficit countries. Consequently the U.S. government has found it necessary to restrict production and to take over large surpluses.

The Purpose of Supporting the Price of Palay

The price of palay is already supported indirectly by the restriction of imports of rice. Without import restriction the price of palay would fall to the level of prices in exporting countries plus the cost of importation. This is the easy way to support prices up to the point where the country becomes self-sufficient. No government-buying program is necessary. The price operates within the supply and demand situation in the restricted market. Producers receive more for palay and consumers pay more for rice. If palay production is profitable and production facilities are available, production will increase up to the point of self-sufficiency.

During recent years the Philippines has been almost self-sufficient in palay. What is the purpose of a price support program

¹ General Contribution No. 878. Prepared in the Department of Agricultural Economics.

now? Presumably the support level will be higher than the present protected price. Is the objective to raise production to the self-sufficiency level? Is it to create a surplus which cannot be consumed without a decline in prices or a loss to the government? Is it to raise farmers' income? Or is it for some other purpose?

The first thing to decide is the purpose. Once the purpose is determined, the program should be developed so that the purpose will be realized. It might be that other programs are more suitable to reaching the objective than is a price support program.

Alternative programs include:

1. Increased research on production and marketing.
2. More effective education on production and marketing.
3. Improved assistance in production as offered by the DANR.
4. Practice-payments such as paying individual farmers if they use certain improved practices.
5. Improved marketing so that farmers receive a higher price with no higher retail prices of rice.
6. Selective support such as limiting the support to the first 20 cavans or to some other limited amount.
7. A combination of one or more of the above.

At What Level is the Price to be Supported?

If a price support program is the best alternative, the level of support will depend on the objective of the program and the resources available to implement it.

Much has been and will be said about the cost of production plus some fair profit. Figures will be assembled to justify certain levels of support. Whatever these "prove" or "disprove" certain things must be kept in mind.

Under production conditions as they exist in the Philippines the two major items of cost are man labor and the use of land. Neither of these is purchased each year to any extent by farmers for the purpose of producing palay. Hence, the real cost is difficult or impossible to determine in the same way as the cost of fertilizer or insecticides is determined. What really happens is that a farmer and his family use their labor for producing a crop in the expectation of getting some return. Any return, low as it may be, is better than no return. Much the same is true of land.

Those who attempt to determine the costs of production either measure the amount of time spent on the crop or estimate it. They then determine the total value of this time by multiplying the amount of time by what the farmer says his time is worth or by arbitrary figure such as the minimum wage. In neither case is this an actual cost paid by farmers but an imputed cost.

Somewhat the same situation exists with land. The usual charges for the use of land include taxes and interest on the value of the land. The value of the land must be determined; the assessed value, the market value or an arbitrary value might be used. Taxes are ordinarily fairly easy to determine but the same is not true with the interest charge. Should the charge be zero, 5%, 6%, 10%, 12% or some other figure? Whatever it is, it is not necessarily a cost paid by the landowner but an imputed cost based on the valid assumption that landowners must receive something on their investment or palay would not be produced.

Hence, although we calculate costs to the last centavo, it must be kept in mind that the calculation is an approximation and is not as precise as something assumed.

Finally, whatever methods and assumptions are used in calculating costs of production, it will be found that they vary widely. Cost will vary between farms and between areas. Cost will vary from less than the going price for palay to several times the going price. Even the average cost is often above the going price. This means that many farmers are not receiving as much for their labor or their capital or both as was included in the cost computation. It does not necessarily mean that they are losing money.

No government can support the price as high as the cost of production of the high-cost farmers. The level of support should be determined by the objective to be accomplished rather than by the cost of production.

How is the Price to be Supported?

Various methods of supporting prices have been used. Probably the most common is for the government to offer to buy or to make a loan on palay offered by farmers. This requires facilities and personnel throughout the palay-producing areas. If carried out in the Philippines it would seem that NARIC and ACCFA facilities

should be used. However, if more palay is acquired than can be sold at the support price, these agencies should not have to assume the burden of losses.

Some countries have attempted to support prices by buying products at established prices from marketing agencies rather than from the farmers. Thus, in the U.S., dairy product prices are supported by buying cheese, butter and milk from manufacturers who buy milk from farmers. This operates on the assumption that prices to farmers rise in line with the buying prices of the manufactured products. Although in general this is true, it may not be in areas where competition is lacking.

A third practice is to pay farmers a direct subsidy on the amount marketed and permit the price in the market to operate with no direct support.

Is Price Support to be Uniform?

Will the government support the price of ordinary palay at the same price as fancy palay? If it does it will discourage the production on the fancy varieties. Will it support the price of a given quality of palay at the same level in the interior of Mindanao as near Manila? If so, areas distant from market will be given greater benefits than those near market. Furthermore, the support price plus marketing costs for palay grown in distant areas will exceed those for palay grown near market. Distant areas will benefit more than nearby areas and at greater cost to the government.

Finally, will the support level be as high in December as in June? If so, the tendency will be for farmers to sell to the government at harvest time and let the government assume the costs of storage from the time of heavy harvest to the time of consumption.

CONCLUSIONS

A price support program is complicated and can be costly to the government, to the consumers or to both. It should be undertaken only if there is no better way to realize a desirable objective. The first consideration is to determine the objective. The second step is to select the best method to realize the objective. The level of support and the variation in support level by quality, distance from market, and season of the year should be carefully considered. If not, the support program could easily encourage the production of low quality palay, in areas distant from markets at a price which consumers will not pay. Such a program might create more problems than it solves.

THE FARMER'S COST OF PRODUCING PALAY¹

E. U. QUINTANA, J. C. STA. IGLESIA, and H. VON OPPENFELD

How much does it cost to produce one cavan of unhulled rice or palay? This question is of vital interest to farmers who expect a fair return to land, labor, and capital. If the production cost has any influence on domestic price of rice, consumers have an equal interest. Even more concerned are politicians and government agencies as the price of this staple food affects the welfare of most Filipino farmers and consumers.

Studies conducted by College of Agriculture students for the crop year 1954-55 reveal an average production cost of ₱10.08 per cavan of palay. Whether or not we accept this we must ask several additional questions. Whose cost is this, where and how was it obtained? How valid is this average cost for different farmers in various rice-growing areas of the Philippines? The studies of the 26 Los Baños students bring into sharp focus the extreme variation in production cost, from area to area, town to town, and even from farm to farm.

The surveys were primarily designed to provide information on land use, tenancy, and farm management practices. Students obtained data from 1,513 tenants on lowland farms in 15 provinces of Central and Southern Luzon, the Bicol, and the Visayas. These farms were specialized in lowland rice production and had no other commercial farm enterprises. Detailed information on field size, land values, draft animals, equipment, supplies and input of hired and family labor made it possible to compute the cost of producing palay although this study was not originally designed for this purpose.

In a sense, the information on cost of production is a by-product of a larger research undertaking. It lacks the detailed breakdown of labor input for each step of the field operation. As a survey, it is based on the farmers' memory of past activities, not on day-to-day recording. It is restricted to tenant farms.

¹ Central Experiment Station Contribution No. 1922. Prepared in the Department of Agricultural Economics.

Postwar Studies Show Apparent Agreements

In view of these limitations, it is desirable to compare the average cost per cavan of ₱10.08 with cost figures from other post-war studies (table 1).

TABLE 1.—A comparison of four cost studies in the Philippines, 1952-1955, showing average cost per cavan of palay

CROP YEAR	AGENCY CONDUCTING STUDY	FARM AREA	NUMBER OF FARMS	COST PER CAVAN
				<i>pesos</i>
1952-53 ^a	College of Agr., U.P.	Iloilo		
		(non-irrigated)	49	10.14
		(irrigated)	49	10.44
1952-53 ^b	Central Luzon Agricultural College	Muñoz	Not published	10.49
1953-54 ^c	College of Agr., U.P.	Lupao	95	7.16
1954-55	College of Agr., U.P.	Philippines	1513	10.08

^a Quintana, E. U., *Philippine Agriculturist*, 39, 365-368 (1955).

^b Matela, A. B., *Agricultural and Industrial Life*, April, (1953).

^c Memita, S. O., "Cost of Producing Palay in San Roque, Lupao, Nueva Ecija." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1953. Unpublished).

The average cost per cavan was approximately ₱10 in three of the four studies. Although obtained by different research workers, by different methods, at different periods, and in several provinces, these average cost figures are in surprising agreement. This tends to give us confidence in our cost figures. One might even conclude that a cost per cavan of ₱10 is valid for most farms in the major rice-growing areas.

In the fourth study, however, Lupao farmers produced rice at ₱7.16 per cavan, approximately ₱3 below their fellow farmers' cost. Their savings were mainly due to double-cropping. This reduced the charges for land use, draft animals, farm equipment, and family labor. Such conditions, coupled with good yields, mean lower cost per hectare.

Cost Varies from Area to Area

The writers readily admit some variation in the production cost. But they may question whether Lupao farmers could possibly produce at a cost 30 per cent below their fellow farmers in Muñoz. To get a realistic view of the prevailing variation the studies of the 26 students by cost per cavan were arrayed from low-cost to high-cost areas (table 2).

Farmers in Tarlac raised their palay at less than half the ₱10 average. Costs were below ₱8 in seven studies representing 479 farmers in seven provinces, below ₱10 in eleven studies representing 667 farms.

At the other extreme, some farmers in Rizal and Pangasinan were found to have high costs, averaging approximately ₱22. We may discount these two cases because of high land values in suburban Baras, Rizal and water-logged conditions resulting in low yield in Manaoag, Pangasinan. Nevertheless, costs were above ₱13 in seven studies representing 353 farms, and above ₱11 in twelve studies representing 616 farmers.

TABLE 2.—*Cost of production studies grouped by cost per cavan of palay in 1513 lowland tenant farms in 15 provinces, P.I., 1954-55*

PROVINCE	MUNICIPALITY	NUMBER OF FARMS STUDIED	YIELD PER HECTARE	PRODUCTION COST	
				Per hectare	Per cavan
			<i>cavans</i>		<i>pesos</i>
Tarlac	Tarlac	30	37	173	4.67
Albay	Three towns	32	39	236	6.03
Cam. Sur	Three towns	44	40	268	6.66
Laguna	Biñan	120	49	334	6.77
Nueva Ecija	San Isidro	111	53	384	7.18
Albay	Guinobatan	60	29	224	7.66
Bulacan	Baliwag	82	65	512	7.83
Laguna	Calamba	67	66	628	9.51
Pampanga	Three towns	29	34	328	9.60
Tarlac	La Paz	76	29	280	9.68
Capiz	Batan	16	24	243	9.94
Rizal	Marikina	88	42	419	10.10
Albay	Oas	116	24	244	10.16
Nueva Ecija	Muñoz	26	54	578	10.76
Quezon	Lucena	33	29	323	11.23
Laguna	Nagcarlan	18	36	428	11.78
Bataan	Abucay	75	34	428	12.66
Bulacan	Three towns	43	44	568	12.85
Laguna	Cabuyao	94	58	750	12.96
Cavite	Imus	119	35	461	13.01
Zambales	Three towns	26	30	436	14.59
Rizal	Tanay	37	36	529	14.71
Leyte	Palompon	18	23	344	14.71
Cavite	Imus	114	33	534	16.41
Rizal	Baras	16	46	1,006	21.59
Pangasinan	Manawag	23	22	483	22.28
Weighted Average, All Farms		1,513	42	427	10.08

The array by cost per cavan demonstrates the extreme variation in cost from region to region, from province to province, and even from town to town. In addition, one notes the wide range in cost and yield per hectare, as shown in table 2. These two factors explain much of the variation in the cost per cavan.

Cost Varies from Town to Town

In interpreting these figures readers must also keep in mind that costs obtained in each study are averages for all farmers in the particular town or barrio. In other words, not every farmer in San Isidro, N.E., produced at a low cost of ₱7.18 nor did every farmer in Abucay, Bataan produce at the relatively high cost of ₱12.67. This is illustrated by a frequency distribution (table 3).

TABLE 3.—*Individual farms grouped by cost per cavan in 274 tenant farms in Central Luzon*

COST PER CAVAN (Range)	NUMBER OF FARMS		
	Low cost San Isidro	High cost Abucay	Near av. cost Marikina
Below 5.50	19		2
5.50-6.99	23	4	5
7.00-8.49	27	8	16
8.50-9.99	18	5	18
10.00-11.49	10	9	17
11.50-12.99	4	9	12
13.00-14.49	2	8	6
14.50-15.99		5	5
16.00-17.49	1	6	1
17.50-19.00		3	2
Above 19.00	2	18	4
Number of farms	111	75	88

Variation from farm to farm within a town or barrio was also great. This is no surprise to those who are familiar with cost studies. Whenever one studies the cost of producing a unit of grain, vegetables, milk or eggs, costs vary as much or more from farm to farm than from area to area. It is no surprise then to find extreme variation in cost of palay from farm to farm. There is no such thing as a uniform production cost within a single town or barrio.

An itemized breakdown of the cost per hectare was made by selecting a low-cost study and a high-cost study averaging nearly 30 per cent below and above the average, respectively (table 4). Itemized costs per hectare were also listed for one study with near average cost.

TABLE 4.—*Cost of producing lowland palay in 274 tenant farms in Central Luzon*

ITEM	LOW COST	HIGH COST	NEAR AV. COST
Town	San Isidro	Abucay	Marikina
Province	Nueva Ecija	Bataan	Rizal
Number of farms	111	75	88
Cost per cavan (pesos)	7.18	12.67	10.13
Land	110	<i>Pesos per hectare</i> 80	144
Land tax	6	4	7
Work animals	13	15	24
Tools & equipment	9	13	10
Seeds	8	10	6
Irrigation	14	—	—
Fertilizer ^a	^b	—	1
Other cash expenses	10	33	1
Hired labor	16	17	31
Operators' & family labor	133	209	162
Harvesters' & threshers' share	65	46	34
Cost per hectare	384	427	420

^a Farmers who fertilized spent P11.20 per ha. for commercial fertilizer in San Isidro and P5.43 in Marikina.

^b Less than 0.5.

Yield, Land and Labor Charges Influence Cost

The cost per hectare in these three studies was relatively uniform, ranging from P284 to P427. Yield per hectare on the other hand, averaged 53.4 and 33.7 cavans. The difference in yield explains much of the variation in cost per cavan, inspite of little difference in cost per hectare. Yield is generally an important factor influencing cost per unit.

Other factors are farm size, land value, days of labor, and wage rate of hired and family farm labor (table 5). Farm size influences the efficiency of farm labor, work animals, tools and equipment. Land value determines the charge for land use. In this study, market values for land were obtained from the farm operator. Market value was considered to reflect better the economic value of land as a factor of production than assessed valuation. The charge for land use was then computed by assuming an arbitrary interest rate of 6 per cent yearly. Whether or not this interest rate is adequate is subject to debate. Some farmers attain a higher return while others receive less for their capital investment in farm land. When double-cropping was practised the land cost was allocated to both crops.

TABLE 5.—*Some factors affecting production cost*

ITEM	LOW COST	HIGH COST	NEAR AV. COST
Factors:			
Yield (cavans per hectare)	53.4	33.7	41.4
Size (hectares per farm)	2.8	2.1	3.6
Land value (pesos per hectare)	1838	1343	2398
Labor (days per hectare)	74.5	95.8	87.5
Wage rate (pesos per day)	2.00	2.36	2.20

To determine the cost of labor, farmers were asked to give the actual expenses for hired labor. The cost of labor furnished by the operator and members of the family was obtained as follows: The farmer stated the time spent by himself and by members of his family. He also valued his own time and that of his family.

Operator's and family labor accounted for at least one-third of the total growing cost. Second among the cost items was the charge for land use. Taken together these two were approximately two-thirds of the total cost. Neither land use nor family labor involve cash or out-of-pocket costs. It is extremely difficult to determine them objectively. Land values depend on the farmer's judgment; the rate of interest is determined by the researcher. Similar value judgment is involved in placing a value at the self-supplied farm labor. In general, farmers' return to labor is less than the farm wage rate stipulated by law. It is therefore not logical to compute farm labor charges at the minimum wage rate. This method makes little sense in an economy where alternative employment opportunities are scarce. Objective valuation of the two main cost items, family labor and land use, is always difficult. This is a serious limitation of all cost studies.

CONCLUSION

Three out of four independently conducted studies show an average cost of approximately ₱10 per cavan. This apparent agreement does not mean that the majority of farmers produce palay at this cost. Extreme variation in cost was demonstrated from area to area, from town to town, and from farm to farm. The variation is due to differences in yield, cost of land use, and cost of labor. Land charges and family labor together accounted for at least two-thirds of the total cost. Objective valuation of these two cost items is extremely difficult. Because of the variation in cost and the difficulty in determining land and labor charges it is advisable to exercise extreme caution in the interpretation of cost of production data.

ORGANIZATION AND OPERATION OF DUCK FARMS IN MAYONDON AND BAYOG, LOS BAÑOS, LAGUNA ¹

DALMACIO A. CRUZ

WITH ONE TEXT FIGURE

The duck raisers kept an average of 241 birds valued at ₱903. The yard space per bird was less than a square meter. Snails and palay composed the main feed of the ducks. Gathering snails made up the bigger portion of labor in duck raising. January to May, and June to October, were months of highest and lowest egg production, respectively.

Incomes varied widely. Small farms had negative farm incomes and labor earnings. Factors directly related to returns from ducks were volume of business, rate of egg production, hour input, and months spent on the enterprise.

A knowledge of the organization and management of duck farms is important in order to understand the nature, the problems, and ways of improving the local duck industry which is concentrated in the towns along Laguna de Bay in the province of Laguna and in Rizal. Such information was gathered in the summer of 1954 by interviews with 153 duck farmers in Mayondon and Bayog, Los Baños, Laguna.

THE SURVEY AREA

Mayondon and Bayog are adjacent barrios that lie along the shore of Laguna de Bay. Both areas are about two and one-half kilometers from the U.P. College of Agriculture.

THE FARM OPERATORS

The farm operators ranged from 17 to 70 years of age with more of the older farmers in Bayog. The farmers in Bayog had less

¹ Central Experiment Station Contribution No. 1923. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1956. Prepared in the Department of Agricultural Economics under the direction of Assistant Professor Nathaniel B. Tablante, Dr. L. S. Robertson, former visiting Cornell professor and Dr. Francisco M. Fronda.

formal education than those in Mayondon, but they had more experience, both in terms of years engaged in duck farming and of years operating their present farms (table 1).

TABLE 1.—*Characteristics of the farm operators by barrios in 153 farms*

ITEM	AVERAGE YEARS		ALL FARMS
	Barrio		
	Mayondon	Bayog	
Age of farmers	40	43	41
Years spent in school	2.4	1.4	2.0
Years engaged in duck raising	16	18	16
Years operating present farm	12	16	13

Practically all the farmers reported that they inherited the duck business. Burgos² stated that when the Spaniards published the "Agricola de Filipinas" there were already 1,000,000 ducks in Pateros and Taguig, Rizal, the towns on the opposite shores of Laguna de Bay. The ducks were presumed to have been brought by the Chinese traders who settled there before the Spaniards discovered the Islands.

THE DUCK FARMS

The 153 farms were relatively small in area. The ducks occupied less than a square meter of yard space per bird. The area devoted to ducks and its corresponding value increased as the flocks became bigger. For all the farms the average size of an entire farm was only slightly more than one-tenth of a hectare. The duck yards averaged less than 200 square meters.

The flocks. Only the native ducks (*Anas domestica* Linn.) popularly known as "itik" were raised. At the time of the survey, the average size of the flocks for all farms was 241 birds, valued at about ₱4.00 per bird (table 2).

It is claimed that duck's meat has a fishy taste. For this reason a very small number of birds were sold and consumed by the farmers. These were composed largely of aging layers and excess drakes. Death of some birds was attributed to botulinus poisoning. This occurred when dead snails or decomposing organisms were eaten.

² C. X. Burgos, *Agricultural and Industrial Life*, 8, 36-37 (March, 1951).

TABLE 2.—*Ducks to a flock and value by size group in 153 farms*

ITEM	SIZE GROUP								All farms	
	50-149		150-249		250-349		350 & more			
	Num- ber	Value	Num- ber	Value	Num- ber	Value	Num- ber	Value	Num- ber	Value
	P		P		P		P		P	
Beginning inventory	98	366	123	728	183	1089	272	1740	153	862
Less: Sold	5	18	3	11	3	10	16	68	6	25
Consumed	2	9	4	14	4	15	9	32	5	16
Died	13	34	17	13	27	54	52	109	24	55
Sub-total	78	305	99	690	149	1010	195	1531	118	766
Plus: Bought	57	79	84	97	139	100	285	323	123	137
Ending inventory	135	384	183	787	288	1110	480	1854	241	903

The cost of replacement was relatively small because most of the farmers acquired female ducklings for about a peso each.

About two-thirds of the farmers started or renewed their flocks by purchasing out of savings and with the aid of loans to be paid back in eggs. Significantly, only one duck raiser operated a hatchery and hatched his own ducklings. Thirty-three farmers or 21 per cent renewed or started the flock strictly on purchase basis. Twenty-eight or 18 per cent of the duck raisers obtained their stock by loan, while the rest employed a combination of both purchase and loan methods of acquiring birds.

Age of ducks. Young birds whose ages ranged from 2 to 3 years made up two-thirds of the flocks studied. These were kept in readiness to replace aging layers. The owners of larger flocks did not keep ducks older than 3 years.

Feeds and feeding. Snails (fig. 1) which are scooped from the depths of Laguna de Bay and palay were the main components of the feeds. Corn and shrimps were fed in limited amounts. Boiled rice or corn bran, "tahup sa mais," were given as "starter" to ducklings. These were gradually substituted by palay and snails as the birds grew older.

The snails are gathered at dawn and are piled in heaps under a shade close to the duckyard. The day's haul usually lasts till the following morning. Daily scooping is done to keep the snails fresh and alive.

Almost all the operators fed their flocks as often as feed in the trough was consumed. Only one-fifth of the duck raisers observed specific feeding schedules.

There was no incidence of pest and diseases at the time of the survey.

The ducks lay eggs at dawn. The eggs which are laid on one common corner of the yard are collected before sunrise.

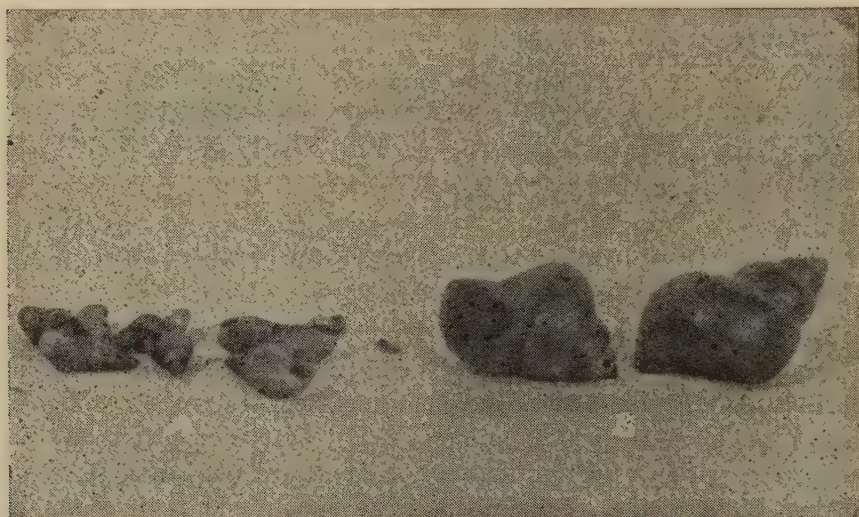


Fig. 1.—Kinds of snails^a scooped from the depths of Laguna de Bay. (A) “Buele,” *Melania lateritia* Lea; (B) “Papa,” *Paludina angularis* Mueller.

^a Identified by Dr. S. M. Cendaña of the Department of Entomology.

The farm labor. In all cases, the operator contributed the largest share of farm labor (table 3). Larger farms required more months of labor with each increment in number of birds per flock.

TABLE 3.—Labor force on the farm by size group in 153 farms

ITEM	FARMS GROUPED BY NUMBER OF DUCKS					All farms
	50-149	150-249	250-349	350 and more		
	Average months worked					per cent
Operator	5.5	6.8	7.6	8.2	6.7	39
Wife	4.7	5.3	4.9	5.2	5.3	29
Sons	2.2	2.0	5.7	6.3	3.6	22
Daughters	2.2	0.7	1.1	1.2	1.4	7
Others	0.3	0.1	0.5	1.1	0.4	3
Total	14.9	15.9	19.8	22.0	17.4	100

However, the labor input increased only 50 per cent while the number of birds per flock more than doubled.

Use of labor. The gathering of snails made up almost one-half of the average total hours devoted to ducks (table 4). Some operators in Bayog whose farms are quite far from the shore used carabao labor for hauling snails.

Except for marketing eggs, the number of hours spent for each job tended to increase with the increase in size of the flocks.

TABLE 4.—*Use of labor in 153 farms*

ITEM	AVERAGE HOURS				PER CENT OF TOTAL
	Size Group				
	50-149	150-249	250-349	350 & more	
Collecting snails	571	1233	1661	1744	47.4
Feeding	594	709	949	1106	30.4
Collecting eggs	47	66	71	98	2.6
Marketing eggs	15	26	22	38	0.9
Repair of buildings	6	12	14	20	0.5
Repair of tools	6	7	8	10	0.3
Repair of duck fence	10	11	13	16	0.5
Cleaning duck yard	298	381	444	589	15.5
Animal labor	0	70	146	10	2.0
Total	1547	2515	3328	3661	100.0

Variation in labor requirement. Labor input per farm increased with the size of flock but the increase was not proportional to the increase in size (table 5). The number of birds to a flock influenced greatly the amount of work accomplished by each workman. This seemed to account for most of the variations in the amount of work accomplished in relation to the labor available.

Although operators of large flocks were busy only a small part of the day, the smaller flocks provided even less work to keep the

TABLE 5.—*Labor requirement, work load, and hours per duck in 153 farms*

DUCKS PER FARM	NUMBER OF FARMS	LABOR REQUIREMENT	WORK LOAD	HOURS PER DUCK TO A YEAR
		Hours/farm/day	Hours/person/day	
50-149	153	4.2	2.4	17
150-249	51	6.9	3.1	14
250 and more	52	9.3	2.7	9
All farms	50	7.0	1.5	11

workers busy. Feeding, gathering snails, and other chores can be performed with less waste of time with large rather than with small flocks.

Increase in farm size resulted in increased time spent by workers. This effect is associated with greater accomplishment in terms of hours required per duck or ducks per person in labor force. It took almost the same number of persons to care for 90 birds as it did to care for 400 birds (table 6). On the average, each person on the smaller farms attended to only 32 ducks as against 130 for the larger farms. Owners of large flocks utilized labor more effectively than owners of small flocks.

TABLE 6.—*Ducks per person to a year in 153 farms*

DUCKS PER FARM	NUMBER OF PERSONS	NUMBER OF DUCKS	DUCKS PER PERSON IN LABOR FORCE
50-149	2.9	91	32
150-249	2.6	183	72
250 and more	3.1	405	130
All farms	2.8	227	80

Production of eggs. Eighty-two per cent of the duck raisers reported that their flocks were in highest production during the months of January to May, inclusive. From the same report, 18 per cent did not specify month ranges. During the heavy rains from June to October, inclusive, production was at its lowest. A similar pattern of production has been observed in Pateros.⁴

Rate of egg production. The farmers' estimate of egg production averaged 210 eggs yearly. Increase in production rate by flock size was insignificant. The estimate of egg production by the farmers themselves is probably a little too optimistic, although a native duck, if well fed and taken care of, can lay from 150 to 200 eggs a year.

Fronza and Basio⁵ reported that three lots of laying ducks raised in battery cages and fed with mash⁶ morning and afternoon

⁴ Burgos, *Ibid.*

⁵ F. M. Fronza and Engracio Basio, *Philippine Agriculturist*, 28, 152-157 (1939).

⁶ Considered best feed for egg production in ducks consisting of 52.5 parts of rice bran, 17.5 parts of corn meal, and 30.0 parts of fish meal, (all parts by weight) and supplemented with 4 per cent cod liver oil, 1 per cent common table salt, 3 per cent ground shell and green grass daily.

had an average egg production of 202 to 236 eggs, the highest individual yearly egg record being 320 eggs.

COSTS, RETURNS, AND PROFITS

Capital investment per layer was ₱16.23. Because of small space required per bird, land made up only about 30 per cent of the investment. Naturally, as the size of flock increased, more capital was needed in all forms (table 7). Investment per bird, however, decreased as the size of flock increased. The capital investment per layer by size of flock averaged ₱15.70 for all farms; ₱19.22 for small farms, ₱19.07, for medium farms and ₱14.55, for large farms.

TABLE 7.—*Capital investment in 144 farms*^a

ITEM	PESOS PER FARM			All farms	PESOS PER LAYER
	Farm Size ^b				
	Small	Medium	Large		
Land value	P276	P 551	P 991	P 624	P 4.87
Ducks	423	703	1362	853	6.67
Equipment & Tools	186	424	659	434	3.40
Buildings	107	116	259	165	1.29
Total	P992	P1794	P3271	P2076	P16.23
Investment per layer	P 19.22	P 19.07	P 14.55	P 15.70	—

^a Nine farms which were newly started and/or acquired and did not have income at the time of the survey are not included in this table.

^b Small farms, less than 75 layers; Medium, 75-120; Large, 121 and above (the last group includes flocks of as large as 700 and 800 layers).

Capital and operating cost. Next to feed and labor, capital cost in duck farming was the most important expense (table 8). Ducks made up the biggest item in the capital cost followed by land and equipment items primarily motorboats and banca. The cost for tools was almost negligible. The increase in farm size was accompanied by an increase in capital and operating cost.

The cash payment for snails was very much less on the larger than on the smaller flocks (table 9). For the bigger flocks the amount spent for gasoline, etc., increased considerably. The large flock operators used motor boats for gathering snails whereas most operators of small flocks did not own motorboats.

Charges for unpaid labor constituted the biggest item in the operation with the ₱3.00-a-day rate which prevailed at the time of the survey.

TABLE 8.—*Capital cost in 144 farms*

ITEM		PESOS PER FARM			All farms
		Farm Size			
		Small	Medium	Large	
Land:	Interest	27	61	112	70
	Taxes	5	9	14	10
	Cash rent	4	2	5	4
Ducks: ^a	Depreciation	86	141	226	167
	Interest	50	84	163	102
Equipment & tools:	Depreciation	25	53	89	58
	Interest	22	49	83	56
	Repair ^b	2	3	3	2
Buildings: ^c	Depreciation	13	18	34	22
	Interest	13	14	32	20
	Repair	3	5	6	5
Total capital costs		250	439	767	516

^a Depreciation and interest were charged 20 per cent and 12 per cent respectively, with the former covering the replacement cost if layers were kept an average period of 3 to 4 years.

^b Includes repair on equipment.

^c Twenty per cent of the farmer's house value was added to the cost of duck buildings if the birds were kept under the house.

TABLE 9.—*Operating cost in 144 farms*

ITEM		PESOS PER FARM			All Farms
		Farm Size			
		Small	Medium	Large	
Total capital cost		250	439	767	516
Feeds:	Snails	203	86	40	106
	Palay	244	332	666	425
	Corn	0	0	19	19
	Shrimps	7	3	5	5
Labor:	Food for hired labor	11	19	130	37
	Hired man labor	7	29	189	80
Unpaid labor:	Family	281	321	359	322
	Operator	391	538	565	504
	Animal	3	19	12	12
Gasoline, oil, kerosene, etc.		139	264	386	269
Containers:	Crates	3	4	4	4
	Pails	2	2	3	2
	Kerosene cans	1	1	1	1
Other		39	54	72	56
Total operating costs		1331	1672	2451	1849

Crates were used for transporting the snails from the boats to the yard, and pails or kerosene cans for distributing the feeds to the troughs. Complete replacement of light equipment was almost a yearly necessity.

Gross income. The total gross income came almost entirely from egg sales, ducks being raised principally for eggs. Less than one per cent of the sales was contributed by duck sales (table 10).

TABLE 10.—*Sale of eggs and ducks in 144 farms*

FARM SIZE	NUMBER OF FARMS	PESOS PER FARM		
		Egg sales	Duck sales	Total sales
Small	45	1145	18	1163
Medium	47	2029	11	2040
Large	52	4652	45	4697
All farms	144	2614	25	2819

Profit and loss. In analyzing profit and loss for each farm, an interest of 12 per cent was made on the values of land, ducks, buildings, equipment, and tools. Depreciation charges to capital items, and the value of labor of operator, family and animal labor were likewise considered. These charges increased the operating costs and to a large extent, accounted for the losses of small and medium-sized farms (table 11). As a practice, however, the duck raisers do not regard some of such charges as production costs.

TABLE 11.—*Profit and loss on duck enterprise in 144 farms*

ITEM	PESOS PER FARM			ALL FARMS
	Small	Medium	Large	
Receipts	1163	2040	4697	2819
Less: Capital and operating costs	1581	2111	3218	2465
Profit or loss	-418	-71	1479	354

Net farm income and labor income. The net farm income is the difference between total farm receipts and all farm expenses except interest on capital and the value of the farmer's labor. It represents the operator's returns, both for his labor and farm capital. Unlike in the profit-and-loss measure, neither the wages of the operator nor interest cost have been included in the expenses; hence, the difference in the results of the two measures. Profits averaged ₱345 for

all farms (table 11), while the net farm income averaged ₱1187 for all farms (table 12).

The labor income represents the value, other than privileges, that the operator gets for his own labor; thus, interest for use of the capital is deducted from the net farm income. The operators had an average labor income of ₱906.

Labor earnings. The operator's labor earnings consisted of the labor income plus the value of farm privileges. This is a more adequate measure of returns than labor income alone as it includes the value of farm produce consumed by the operator's family.

Fifty-two farmers who kept about 121 layers to 800 layers had average labor earnings of ₱2392. By contrast, 45 operators who kept fewer than 75 layers had average labor earnings of only ₱2 (table 12). In duck farms where the operator's household used a very small proportion of eggs and ducks, labor earnings were practically the same as labor income.

Amount available for family living. The amount available for family use of all members in the operator's household consists of labor income, farm privileges, and the value of unpaid family labor and non-farm family incomes (table 12). This measure of income includes incomes and earnings, both from ducks and off-farm jobs that would be available for family living, investment, education and other uses.

This computation renders the operator's family comparable to other families engaged in other means of livelihood.

WHY SOME FARMS PAID BETTER THAN OTHERS

The variation in incomes among farms, was due largely to volume of business. Given sufficient capital to increase the size of his flock and ability to manage a larger flock, a duck raiser is likely to be better off with a large business. Other factors such as age and experience of the operator tended to influence incomes, but these were not as important as the size factor.

Size of flock. The large farms had a decided advantage over small and medium-sized farms. All the measures of success were positively related to farm sizes (table 12). Farm and family incomes became better as the volume of business increased.

Operators of large duck farms had bigger incomes than operators of small farms. The latter did not earn enough from off-farm occupations to offset the low returns from the farms.

TABLE 12.—*Farm size, net farm income, labor income, labor earnings, and amount available for family living in 144 farms*

FARM SIZE	NUMBER OF FARMS	NET FARM INCOME	LABOR INCOME	LABOR EARNINGS	AMOUNT AVAILABLE FOR FAMILY LIVING
Small	45	P -6	P -199	P 2	P 441
Medium	47	723	516	655	1186
Large	52	2637	2161	2392	3298
All farms	144	P1187	P 906	P1078	P1761

Months of work. The number of months spent on ducks is related to the size of flocks and in turn to incomes. As more months of work were devoted to the ducks, the labor income and labor earnings rose steadily (table 13).

TABLE 13.—*Relation of months spent on duck farms to labor income and labor earnings in 144 farms*

NUMBER OF MONTHS	NUMBER OF FARMS	SIZE OF FLOCK	LABOR INCOME	LABOR EARNINGS
4 and less	28	89	P 465	P 596
5-8	77	126	801	993
9 and more	39	159	P1424	P1593

Labor efficiency. The number of hours spent to a duck was related to size of flock and in turn to profits. As flocks increased in size, hours to a duck declined. The lower the number of hours to a duck, the higher the incomes became. High incomes and earnings were observed on farms with high labor efficiency (table 14).

TABLE 14.—*Relation of hour input to labor income and labor earnings in 144 farms*

HOURS PER DUCK/YEAR	NUMBER OF FARMS	SIZE OF FLOCK	LABOR INCOME	LABOR EARNINGS
Less than 8.1	21	230	P2191	P2374
8.1-12.0	47	128	794	949
12.1-16.0	34	111	819	945
16.1 and more	42	90	561	684

Average egg production. A consistent relationship was found between the rate of production per layer and income. This was probably influenced by the age of layers or flock management or

both. Before discussing these relationships one limitation of this study should be mentioned. None of the operators kept records on production of egg sales. Production figures, therefore, are based on the operator's recollection of the past year's performance of his flock. Layers with an annual yield of less than 150 eggs incurred negative incomes and earnings for the operator. As would be expected, the efficient layers with an annual yield of 251 eggs and more gave the duck farmer the best returns (table 15).

TABLE 15.—*Relation of average egg production to labor income and labor earnings in 144 farms*

EGGS PER YEAR	NUMBER OF FARMS	L' BOR INCOME	L BOR EARNINGS
Less than 150	16	P -63	P -40
150-200	36	315	768
201-250	61	1058	1180
251 and more	31	1847	2000

Operator's education. There was no significant relationship between the operator's educational attainment and his income from ducks. In spite of the lack of formal education 68 operators had some of the highest incomes (table 16). Five operators who either finished or attended high school had negative incomes. They were, however, not fully employed in the operation. Two of them were attending classes while the other three worked off farm more than on the duck farms at the time of the study.

One operator attended college. His income was one of the highest, but as his case was the only one observed, it cannot serve for purposes of inference.

This pattern is in sharp contrast to the findings of other farm management studies conducted in the Philippines where education seems to be closely related to farmers' income. Income on duck farms in these two barrios depended largely on the size of the enterprise. The farmers who had the most education had the least number of ducks.

Experience. There was some relationship between the length of time that the farmers had been raising ducks and the incomes (table 17). The relationship, however, did not follow a consistent pattern. It was probably influenced more by age of operator and size of business than by experience.

TABLE 16.—*Relation of levels of education of operator to labor income and labor earnings in 144 farms*

LEVELS OF EDUCATION	NUMBER OF FARMS	SIZE OF FLOCK	LABOR INCOME	LABOR EARNINGS	AMOUNT AVAILABLE FOR FAMILY LIVING, ETC.
No schooling	68	118	P1010	P1152	P1768
Primary grades	52	122	939	1158	1844
Intermediate grades	18	165	827	978	1658
Secondary schools	5	111	641	453	49
College	1	50	1035	1143	1332

TABLE 17.—*Relation of experience to labor income and labor earnings in 144 farms*

YEARS OF EXPERIENCE	NUMBER OF FARMS	NUMBER OF LAYERS	LABOR INCOME	LABOR EARNINGS
1-10	54	104	P 647	P 771
11-20	50	138	668	819
21 and more	40	109	1548	1802

Age of operator and size of business. The relation of operator's age and earnings is basically associated with the size factor. Both size of flock and labor earnings rise consistently with increments in age up to the age group of 46 to 55 years (table 18). Up to this age farmers tend to invest their savings in more layers which result in higher incomes. Beyond 55 years age seems to reduce the operator's ability to care for large flocks. The size of flock tends to decline and with it the operator's income.

TABLE 18.—*Relation of operator's age and number of layers to labor earnings in 144 farms*

AGE GROUP	NUMBER OF FARMS	NUMBER OF LAYERS	LABOR EARNINGS
16-25	17	95	P 651
26-35	44	121	887
36-45	36	136	965
46-55	27	146	1574
56 and more	20	132	1395

The size of flock was directly related to the age of the duck raisers. Most farmers did not attain size until they were fairly old. The older farmers who had less or no schooling at all fared better in terms of income. On the other hand, the operators who had

more schooling did not have enough business probably because they were young.

RECOMMENDATIONS

Considering the degree of variation in returns among farms, and in the light of ready markets for "baluts," the duck farmers might do the following:

1. Gradually increase the volume of business on small farms to get better returns and to use labor more efficiently .
2. Organize the farm and labor in order to get improved labor efficiently.
3. Improve their flock management to get high rates of egg production.

Government officials charged with the planning and carrying out of agricultural programs would contribute to the lucrativeness of duck farming by doing the following:

1. Extend credit facilities to duck farmers to enable them to increase their business.
2. Disseminate vernacular literature on duck raising to farmers.
3. Furnish duck raisers with information on egg prices.
4. Conduct further studies on feeding that would keep the level of egg production high during months when snails are scarce.

THE EFFECTS OF TWO-YEAR TREATMENTS OF DIFFERENTIAL FERTILIZER ON THE YIELD OF CORN AND ON THE NUTRIENT LEVELS OF LIPA CLAY LOAM ¹

SANTIAGO N. TILO

There was a response to phosphorus but none to potassium. The overall increase in yield from the application of 90 kilograms of phosphorus (P_2O_5) was 4.4 cavans or 10 per cent higher than yields of plots treated only with nitrogen.

The greatest single factor in increasing corn yield was nitrogen. In the wet season higher yields were obtained with nitrogen than in the dry season. By applying 45 kilograms of nitrogen a yield of 54.7 cavans was obtained. Since moisture was important in growing corn during the dry season, it would be better to put the top dressing two weeks after planting instead of four weeks as observed in the wet season.

Organic matter, available phosphorus and the pH of the soil were not affected by two-year treatments of differential fertilizer. Exchangeable potassium was increased by the application of muriate of potash. The potassium supply in the soil, however, was sufficient to meet the needs of growing crops.

Fertility experiments of long duration are needed to study the various aspects of the use of fertilizers and of the problems arising from their use. Studies have shown that the yield of corn can be increased by the use of fertilizers. Galvez *et al.*² reported that the soils in the College and outlying farms responded to the application of nitrogen. Tests of long duration are also useful to study the effects of fertilizers upon the chemical properties of the soil. Data on this aspect of the problem as related to Philippine soils are limited.

The objectives of this study initiated early in 1954 were (1) to determine the optimum rate of nitrogen for corn when applied alone

¹ Central Experiment Station Contribution No. 1924. Data in this paper were taken from data presented by Galvez *et al.*, 1955 (first and second crops, CF-9A and 9B) and the harvest data of the third and fourth crops (May 25, 1955 to March 7, 1956). Part of the expenses were from a Mathieson-Menzi research grant. Thanks are due Dr. L. E. Nelson, Cornell visiting professor, and Dr. N. L. Galvez, head of the Department of Soils, for their suggestions and to the department staff members who helped during the progress of the work.

² N. L. Galvez, S. N. Tilo, J. G. Davide, M. E. Raymundo and P. A. G. Santos, *Philippine Agriculturist* 39: 337-345 (1955).

and in combination with phosphorus and potassium; and (2) to measure the effects of fertilizer treatments on the organic matter content, available phosphorus, exchangeable potassium, and pH of the soil.

MATERIALS AND METHODS

A green manure crop of mungo was plowed under at the start of the test in May, 1954, and soil samples were collected and analyzed. The values obtained from the soil analysis were as follows: Organic matter, 1.8 per cent; available phosphorus, 53.8 parts per million; exchangeable potassium, 0.87 m.e. per 100 grams; and pH, 6.37. The soil was classified as Lipa clay loam.

A split plot design was used with six replications. The main plot treatments were: (1) No P_2O_5 , (2) 90 kg. P_2O_5 /ha., and (3) 90 kg. P_2O_5 plus 90 kg. K_2O /ha. The subplot treatments were (1) no N, (2) 45 kg. N, and (3) 90 kg. N/ha. Phosphorus was applied as ordinary superphosphate (20% P_2O_5), potassium as muriate of potash (60% K_2O), and nitrogen as ammonium sulfate (20% N).

Five-row plots six meters long were used. Furrows were laid out with the native plow 70 centimeters apart, after which the fertilizers were applied in a band at the bottom of the furrow. The application of fertilizers at planting consisted of all the phosphorus and potassium and one-half of the nitrogen. Cuban Yellow Flint corn was planted at the rate of four to five seeds in hills 50 centimeters apart within the row. Two weeks after planting, the hills were thinned down to two plants each giving a population of 57,200 plants per hectare. The second half of the nitrogen was side-dressed when the plants were four to five weeks old.

The date of planting and harvesting of the four crops were as follows:

<i>Crop</i>	<i>Date planted</i>	<i>Date harvested</i>
First	May 26, 1954	September 4, 1954
Second	November 21, 1954	March 7, 1955
Third	May 25, 1955	September 3, 1955
Fourth	November 23, 1955	March 7, 1956

After the harvest of the fourth crop, soil samples were collected from each plot at a depth of 0-6 inches. Organic matter, available phosphorus, exchangeable potassium, and pH values were determined.³

³ These determinations were performed by P. A. G. Santos, analyst of the Department of Soils.

RESULTS AND DISCUSSION

After the analysis of variance was calculated for the yield of each season, an examination of the error variances showed that they were not homogenous. The data were therefore subjected to the square-root transformation before running the combined analysis of variance. The yield data are presented in table 1 and the analysis of variance of these data, in table 2.

TABLE 1.—*Mean yields of corn grain in cavans per hectare (15% moisture) for the wet and dry seasons in each of two years as affected by nitrogen applied alone and in combination with phosphorus and potassium to a Lipa clay loam*

FERTILIZER TREATMENT	'54 WET SEASON	'54 DRY SEASON	'55 WET SEASON	'55 DRY SEASON	MEAN OVER FOUR SEASONS
<i>Effect of N applied alone</i>					
0-0-0	35.0	14.6	20.5	17.7	21.9
45-0-0	63.7	48.4	55.6	42.5	52.5
90-0-0	83.1	46.8	65.0	42.9	59.4
Mean of N alone	60.6	36.6	47.0	34.3	44.6
<i>N applied in combination with phosphorus</i>					
0-90-0	37.8	20.9	18.8	19.8	24.3
45-90-0	80.8	46.3	51.8	40.1	54.7
90-90-0	90.3	58.7	67.5	43.6	65.0
Mean of N with P	69.6	41.9	46.0	34.5	48.0
<i>N applied in combination with P and K</i>					
0-90-90	45.6	24.4	27.6	23.7	30.3
45-90-90	81.0	45.2	57.5	43.7	56.9
90-90-90	82.7	57.5	64.9	47.6	63.1
Mean of N with P & K	69.8	42.3	50.0	38.3	50.1
<i>Overall effect of nitrogen</i>					
0	39.4	19.9	22.3	20.4	25.5
45	75.2	46.6	55.0	42.1	54.7
90	85.3	54.3	65.8	44.7	62.5
Season means	66.6	40.3	47.7	35.7	47.6

Effects of fertilizers and of seasons on yield

Phosphorus and potassium.—A response to phosphorus was obtained as shown by the F-test (table 2). When phosphorus and potassium were added together, there was no increase in yield over phosphorus without potassium indicating that the potassium supply

in the soil was adequate to meet the needs of the corn crops. The average increase in yield from the application of 90 kg. of P_2O_5 was 4.4 cavans.

Seasons.—Yield of corn was markedly affected by the seasons. Yields were significantly higher in the wet seasons than in the dry seasons. This is to be expected because of differences in the amount of water available to the plants. Yields in the second year were lower than in the first. When nitrogen was applied, bigger responses were obtained with the wet season crops than with the dry season crops. In the wet season there was a response up to 90 kg. of N; this decreased to 45 kg. of N in the dry season.

TABLE 2.—Combined analysis of variance after square root transformation of the yield data

SOURCE OF VARIATION	DF	SS	MS	F
PK combinations	2	7.78	3.89	6.46 ^a
O vs. P & PK	1	5.69	5.69	9.45 ^a
P vs. PK	1	2.09	2.09	3.47
Seasons	3	145.59	48.53	80.61 ^a
Wet vs. dry	1	98.17	98.17	163.07 ^a
Between wet	1	44.94	44.94	74.65 ^a
Between dry	1	2.47	2.47	4.10 ^a
PK combinations × seasons	6	2.59	0.43	<1
Replications	5	7.63	1.53	2.54 ^b
Replications × seasons	15	10.08	0.67	1.11
Error a	40	24.08	0.602	
Nitrogen	2	348.04	174.02	378.30 ^a
N × PK combination	4	4.24	1.06	2.30
N × seasons	6	6.95	1.16	2.52 ^b
N × wet vs. dry	2	3.50	1.75	3.80 ^b
N × '54 vs. '55 wet	2	0.86	0.432	<1
N × '54 vs. '55 dry	2	2.58	1.29	2.80 ^c
N × PK combination × seasons	12	4.45	0.37	<1
Error b	120	55.50	0.463	
Total	215	616.93		

^a Significant at 1% level.

^b Significant at 5% level.

^c F required at 10% level 2.81.

Nitrogen.—The most important factor in increasing corn yields in this test was nitrogen. By applying 45 kg. N, a yield of 54.7 cavans was obtained (table 1). Increasing the nitrogen from 45 to 90 kg. resulted in further increases in yield. A greater portion of the yield increase due to nitrogen was obtained with the first 45

kg. Over the two-year period an average of 0.65 cavan was realized from each kilogram of nitrogen based on the first 45 kg. application and 0.17 cavan based on the second 45 kg. (table 3). Jordan and co-workers⁴ in Mississippi reported a return of one bushel of corn for every two pounds of nitrogen applied as fertilizer up to 120 pounds of nitrogen. This is equivalent to 0.52 cav./kg. nitrogen. Unpublished data of the Soils Department of the College of Agriculture, U.P., from ten fertilizer experiments in Laguna, Batangas and Rizal, indicate 0.50 and 0.22 cavan of grain for the first and second 45 kg. nitrogen applied, respectively.

TABLE 3.—Average return in cavans from each kilogram of nitrogen based on the first 45- and second 45-kilogram applications

SEASON	YIELD OF CONTROL cavans	YIELD INCREASE PER KG. N cavans	
		1st 45 kg. N	2nd 45 kg. N
Wet	30.9	0.76	0.23
Dry	20.2	0.54	0.11
Mean	25.5	0.65	0.17

Season to a large extent affected the efficiency with which nitrogen was utilized by the corn plants. Where there was higher rainfall, higher yield was obtained. Because of its position in the root zone the nitrogen applied at the time of planting during the dry season was utilized more efficiently than the later application. It is highly probable that very little of the nitrogen applied as a side dressing when the plants were four to five weeks old was used. The rainfall data at the time of side dressing support this assertion (table 4).

In the first dry season planting the nitrogen was side dressed on January 5, 1955. Two days after, a rainfall of 1.13 inches⁵ was probably enough to carry the fertilizer into the root zone. Nitrogen for the second dry season crop was side dressed on December 23, 1955. The total rainfall following side dressing amounted only to 2.51 inches, all of which fell as showers of about one-half inch or less. This amount was probably not enough to effect movement of the fertilizer into the root zone of the clay loam soil which may explain the response to the second increment of nitrogen in the first

⁴ Jordan, H. V., K. D. Laird, and D. D. Ferguson. *Jour. Amer. Soc. Agron.* 40, 685-693 (1948).

⁵ Data from the U.P. College of Agriculture Monthly Weather Summaries.

dry season but not in the second. If the total rainfall from planting to harvesting is considered, it will be noted in table 4 that the wet season crops on the average received 23.36 inches and the dry season crops, 13.02 inches.

TABLE 4.—*Rainfall data from planting to harvesting of the four corn crops grown in the wet and dry seasons*

CROP AND SEASON	RAINFALL FROM PLANTING TO SIDE DRESSING	RAINFALL FROM SIDE DRESSING TO HARVESTING	TOTAL FOR GROWING SEASON
	<i>inches</i>	<i>inches</i>	<i>inches</i>
First—wet	7.46	20.59	28.05
Second—dry	8.22	5.32	13.54
Third—wet	7.78	10.89	18.67
Fourth—dry	10.08	2.51	12.59
Mean	8.36	9.83	18.19

Robins and Domingo ⁶ reported that a deficit of moisture before tasseling or pollinating period resulted in yield reduction. Soil moisture data were not taken during the course of the study but the uneven distribution of rainfall and the lack of it caused the plants to wilt.

From the foregoing observations it appears that the nitrogen applied at the time of planting of the dry season crop was utilized more efficiently than the second application made when the plants were four to five weeks old because water became limited at the later stage of growth of the plants. If two applications of nitrogen are desired, the second one should be made two weeks after planting instead of four weeks as practised during the wet season. The split application of the nitrogen would be more effective in the wet season because of a higher rainfall during this period. Furthermore, losses due to leaching would be minimized thereby insuring effective utilization of the nutrient by the plants.

Effects of fertilizer treatments on the nutrient levels and soil pH

The results of the chemical analysis of the soil are given in table 5.

⁶ Robins, J. S. and C. E. Domingo, *Agron. Jour.* 45, 618-621 (1953).

TABLE 5.—*Nutrient levels and pH of Lipa clay loam as affected by nitrogen applied alone and in combination with phosphorus and potassium over a period of four cropping seasons*

a. Organic matter content in per cent

N-LEVELS	PK COMBINATIONS			MEAN
	-0-0	-90-0	-90-90	
0	1.72	1.72	1.76	1.73
45	1.73	1.80	1.77	1.77
90	1.68	1.76	1.81	1.75
Mean	1.71	1.76	1.71	
			L.S.M.D.	C.V.
PK combinations			N.S.	1.6%
N levels			N.S.	1.6%

b. Available phosphorus in ppm

0	50.9	58.1	56.3	55.4
45	41.5	52.0	59.5	51.0
90	49.6	46.3	62.0	52.6
Mean	47.3	52.1	59.3	
			L.S.M.D.	C.V.
PK combinations			N.S.	31.2%
N levels			N.S.	23.0%

c. Exchangeable potassium in ppm

0	160.3	158.7	179.0	166.0
45	148.2	181.8	169.5	166.5
90	151.2	151.7	171.5	158.1
Mean	153.2	164.1	173.3	
			L.S.M.D.	C.V.
PK combinations			5.57 (5%)	4.6%
			7.92 (1%)	
N levels			N.S.	11.7%

d. Soil pH

0	5.87	5.75	5.78	5.80
45	5.73	5.86	5.78	5.79
90	5.73	5.72	5.72	5.72
Mean	5.78	5.78	5.76	
			L.S.M.D.	C.V.
PK combinations			N.S.	3.1%
N levels			N.S.	2.4%

Organic matter content. There were no significant differences in the organic matter contents of plots subjected to different fertilizer treatments. In spite of higher yields obtained from the fertilized plots, the organic matter was maintained. At the start of the test the organic matter content of the soil was 1.8 per cent; after two years, its overall value was 1.7. In this test, the stalks were cut close to the ground and removed from the field.

Available phosphorus. The non-phosphorus treated soil showed 47 ppm available phosphorus which is 7 ppm lower than the phosphorus levels at the beginning of the experiment (54 ppm). On the other hand, the phosphorus content of the phosphorus and the phosphorus-potassium treated soils were 52 and 59 ppm, respectively, indicating that phosphorus addition tended to maintain the phosphorus levels at the start of the test. The differences in available phosphorus levels after two years, however, were not significant. The coefficient of variation of 31.2 per cent for phosphorus analysis indicates the difficulty of adequately sampling soils where the fertilizer has been applied in bands.

Exchangeable potassium. The potassium-treated soils showed 173 ppm potassium whereas the non-potassium treated soils gave 153 ppm for N-O-O and 164 ppm for N-P-O (table 5). These two values, compared with the potassium-treated value, gave highly significant differences in favor of the latter. This showed that the addition of potassium replenished a part of the exchangeable potassium removed. At the beginning of the test the soil contained 339 ppm (0.87 m.e. per 100 grams soil) exchangeable potassium.

Soil pH. The pH of the plots ranged from 5.87 to 5.86 (table 5). At the start of the experiment the pH was 6.37.

The non-nitrogen treated plots showed a mean pH of 5.80 while the nitrogen-treated plots showed a tendency to decrease with the amounts of nitrogen applied. The decrease, however, was not significant although it is known that ammonium sulfate can reduce the pH of the soil through repeated applications. In this test where ammonium sulfate was the source of the nitrogen, no significant differences in pH attributable to differential nitrogen application was observed after two years.

FURTHER OBSERVATIONS ON THE PHOTOPERIODIC RESPONSE OF ELON-ELON RICE¹

F. C. MANUEL and J. R. VELASCO

WITH TWO TEXT FIGURES

Mild temperature during the dark period hastened flowering in rice subjected to short-day treatment. With long-day treatment, it did not induce flowering. Plants subjected to mild temperature produced three times as much grain as those receiving the ordinary night temperature in July.

Naphthalene acetic acid hastened flowering in rice plants when subjected to an inductive cycle, but it could not by itself initiate flowering. The effects of maleic hydrazide when applied during an inductive cycle and when applied before an inductive cycle were inconsistent.

Apparently the most receptive leaf to the photoperiodic stimulus was the youngest fully formed leaf.

The flowering stimulus was transmitted to the ratoons, but not to a neighboring tiller of the same age as the donor.

Continuous illumination elicited a kind of chlorosis which approximated the disturbance caused by an excess of potassium.

The effect of the photoperiod on the shift from the vegetative to the flowering stage of most plants is very marked and rather fascinating. Report has been made that one dark period of more than 10 hours was sufficient to induce flower formation in *Xanthium pennsylvanicum* which can persist unchecked for one year in long days (Hamner and Bonner, 1938). In the tropics where the fluctuation from the typical 12-hour day length does not generally exceed one hour, there is an almost incredibly remarkable seasonal variation in the flowering of plants. Recent studies (Jagoe, 1952; Chandraratna, 1954; Ghose and Shastry, 1954; and Velasco and Manuel, 1955) have shown that certain varieties of rice are good examples of tropical plants, the flowering of which is largely governed by photoperiod. The present study attempts to shed light on the factors that affect the photoperiodic response of the Elon-elon variety of rice.

MATERIALS AND METHODS

Elon-elon seeds harvested from previous experiments and which were on at least their sixth selfed generation were planted in earth-

¹ Central Experiment Station Contribution No. 1925. A part of Research Project No. 952.

en pots each of which contained 3 kilograms of soil. When the seedlings were 5 centimeters tall the five plants to a pot were thinned down to one plant to each pot and fertilized with 3 grams of ammonium sulfate. They were watered at regular intervals to maintain about one inch of water above the soil surface. The plants were exposed to the natural conditions of day-length and temperature during the preliminary 45-day growth period.

Plants in a 10-hour day (short day) experiment were placed in a dark room at 4:00 p.m. and taken out at 6:00 a.m. Where a mild temperature was needed during the dark period, the plants were kept in a light-tight "ice-box" with a minimum temperature of about 21°C.

For a long-day treatment the natural day-length was supplemented with 15 hours of incandescent light. Fifty-watt bulbs strung one foot above the plants were lighted from 6:00 p.m. to 9:00 p.m.

The date when a panicle broke out of boot was considered the date of emergence for the whole hill. Other panicles in the hill which emerged subsequently were not considered. The average of the number of days to emergence for the different hills in a lot was computed.

EXPERIMENTS AND RESULTS

Effect of Temperature on Flowering

Experiment 1. Preliminary study. Seeds were planted on June 10, 1955, and when the plants were 47 days old they were given a 10-hour day and various temperature treatments during the dark period. Lot I was exposed to 35°C; lot II, to an average minimum temperature of 24.4°C.; and lot III, to about 29°C. The extra heat in lot I was provided by incandescent bulbs which were painted black. Lot II was kept in a chamber containing a block of ice, while lot III did not receive any temperature adjustment.

Five days of treatment elicited in lot II a distinct flower bud initiation, and in lot III an apparent swelling of the shoot apex. On the other hand, lot I was still vegetative even with 9 days of treatment. The ages at flower emergence were: lot II, 83 days; lot III, 85 days; and lot I, 88 days.

Experiment 2. Effect of short and long photoperiods with mild temperature. On July 27, 1955, 10 pots from the same group of plants as in experiment 1, were subjected to an average minimum temperature of 21.2°C. during the dark period. Lot I consisting of

5 plants was given a 10-hour day treatment and lot II was given the normal-day treatment which was fairly long.

Five days of short-day treatment in lot I induced the formation of a distinct flower bud. Lot II did not initiate a flower bud until 16 days later. Lot I flowered in 85.6 days of treatment while lot II flowered in 97.2 days. Flowering in lot II was probably due to the shortening day in September coupled with occasional delay in putting the plants out of the "ice-box" in the morning. The unusually long period of treatment in this experiment necessary to elicit flowering finds no immediate explanation.

Experiment 3. Effect of various lengths of mild temperature. Seeds were sown on March 1, 1956, and when the seedlings were 45 days old they were subjected to short-day treatment and various cycles of mild temperature. Lot I was given 5 days of mild temperature; lot II, 10 days; lot III, 15 days; lot IV, 20 days; and lot V, 36 days or up to flower emergence.

There was apparent decrease in number of days to flowering with increasing number of mild temperature treatments up to 15 days (table 1).

TABLE 1.—*Effect of days of mild temperature on flowering*

LOT NUMBER	NUMBER OF DAYS OF MILD TEMPERATURE	DAYS OF TREATMENT TO		AGE AT FLOWERING
		Initiation	Flowering	
I	5	5 ^a	39.25	<i>days</i> 84.33
II	10	5	37.71	83.67
III	15	5	36.83	82.00
IV	20	5	36.50	81.70
V	36 (flower emergence)	5	36.20	85.67

^a Flower primordia were already pronounced.

Experiment 4. Effect of various lengths of mild temperature with short and long photoperiod. This experiment was a repetition of experiments 2 and 3. The seeds were planted on May 24, 1956 and at 45 days, the plants were divided into six lots of ten plants each. Lots I to III were given 10-hour-day treatments and, in addition, lot I received 10 days of mild temperature and lot II, mild temperature up to flower emergence (33 days). Lot IV was left under natural conditions of temperature and day length. Lots V and VI were given a 15-hour-day treatment and the former received additional mild temperature for about two months.

Flower emergence was earliest in lot II which received 10-hour-day treatments and mild temperature throughout the period of treatment (table 2). It was 2.6 days ahead of lot I and 4.6 days ahead of lot III. Lot IV (control) flowered 99 days later than lot II, probably due to the shortening days of October.

TABLE 2.—*Effect of temperature and photoperiod on flowering*

LOT NUMBER	TREATMENT	DAYS OF TREATMENT TO		AGE AT FLOWER- ING
		Initiation	Flower- ing	
I	Short day; 10 days of mild temperature	4	35.8	80.8
II	Short day; 33 days of mild temperature	4	32.2	78.2
III	Short day; no mild temperature	5	37.8	82.8
IV	Normal day; no mild temperature	—	—	176.6
V	Long day; mild temperature, 2 months	87	—	178.0
VI	Long day; no mild temperature	90	—	186.0

There was no sign of boot in lots V and VI one month after the short-day treated plants had flowered. Treatment was then discontinued. Eventual flowering in this lot, like that in the control, was probably caused by the shortening days of October.

Apparently short-day treatment has a predominant effect on flowering and it can not be replaced by mild temperature. The slight hastening caused by mild temperature is just a supplementary effect to the treatment. The striking effect of mild temperature on number and size of panicles was incidentally noted so that a more detailed study of this aspect was made. Results are presented in table 3.

TABLE 3.—*Effect of mild temperature on grain yield*

CRITERION	LOT I 10 days mild temp.	LOT II 33 days mild temp.	LOT III No mild temp.
Ave. panicle per pot	7	9.5	4.5
Ave. grain per panicle	196.6	201.8	232.8
Ave. length of panicle (cm.)	26.8	27.1	26.6
Ave. weight of grains per panicle (gm.)	30.64	31.81	21.88

The highest number and the heaviest panicles were produced in lot II. It was closely followed by lot I which received 10 days of mild temperature. In spite of having the most grains to a panicle

lot III had the lowest weight of grain to a panicle indicating that the grains were not well filled. The yield per pot for lot I was 214.48 grams; for lot II, 302.20 grams; and for lot III, 98.46 grams.

Effect of Growth-regulating Compounds

It was found in the previous study (Velasco and Manuel, 1955) that 50 ppm of either naphthalene acetic acid, indole butyric acid, indole acetic acid or maleic hydrazide had little or no effect on flowering. It was however, thought desirable to survey the range of concentrations before making any conclusion.

Experiment 1. Effect of various concentrations. Seeds were planted on September 19, 1955, and when the plants were 91 days old, they were divided into seven lots of 10 pots each. Lots I, II, and III were sprayed with naphthalene acetic acid (NAA), a growth-promoting substance, and lots IV, V, and VI were sprayed with maleic hydrazide (MH), a growth-inhibiting substance. The solutions were sprayed every other day on the plants until the leaves were drenched.

There was a distinct flower primordium in lot III (300 ppm NAA) on January 9, 1956 or 21 days after the treatment. Ten days later, lots I, IV and VII developed flower primordia.

It seemed that *age at flowering* was inversely proportional with concentration of NAA (table 3). On the other hand increasing MH concentration correspondingly delayed flowering.

TABLE 3.—*Effect of naphthalene acetic acid and maleic hydrazide on flowering*

LOT NUMBER	SPRAY CONCENTRATION	DAYS TO FLOWER		AGE AT FLOWERING
		Initiation	Emergence	
				<i>days</i>
I	100 ppm NAA	31	71.6	162.6
II	200 ppm NAA	27	65.9	156.9
III	300 ppm NAA	21	62.7	153.7
IV	100 ppm MH	31	70.4	161.4
V	200 ppm MH	33	77.0	168.0
VI	300 ppm MH	39	82.4	173.4
VII	Untreated	31	72.9	163.9

Experiment 2. Further study on various concentrations. Experiment 1 gave information on the effect of these compounds on rice when the photoperiod was favorable to flowering. It was thought relevant to find the effect of these substances when the photoperiod

was not favorable, to find whether or not these substances could by themselves initiate flowering. Also, it was decided to spray plants for 10 days only as there seemed to be no need of spraying them up to flower emergence (Sircar and Kunder, 1955).

Seeds were planted on June 12, 1956 and when the plants were 45 days old, they were divided into nine lots of seven plants each. Lots I to IV were sprayed with NAA, lots V to VIII with MH and lot IX received no treatment.

After 6 days of treatment, the plants which received MH yellowed, growth seemed retarded and the leaf blade assumed a perpendicular position with the leaf sheath. The damage was most severe in lot VIII (5,000 ppm MH). Two weeks after treatment, two-thirds of the tillers in this lot were dead. The plants which received NAA were dark green and very healthy. There was, however, no immediate visible effect of any of these treatments on flower bud initiation.

In experiment 1 only 62.7 days were required by the best treatment (300 ppm NAA) to produce flowers, whereas in this experiment flowering took 105 days for the best treatment (5,000 ppm NAA). Data are presented in table 4.

TABLE 4.—*Effect of short-duration spraying with NAA and MH*

LOT NUMBER	SPRAY CONCENTRATION	DAYS TO FLOWER		AGE AT FLOWERING
		Initiation	Emergence	
I	5 ppm NAA	67	115.42	160.42
II	50 ppm NAA	67	114.57	159.57
III	500 ppm NAA	67	111.57	156.57
IV	5,000 ppm NAA	65	105.00	150.00
V	5 ppm MH	69	119.71	164.71
VI	50 ppm MH	69	116.85	161.85
VII	500 ppm MH	67	114.71	159.71
VIII	5,000 ppm MH	77	127.28	172.28
IX	No treatment	67	119.28	164.28

Spraying in this experiment coincided with July which has fairly long days. Flowering was much delayed and must have been caused by the short days in October. This may be taken as an indication that these substances can not by themselves initiate flowering and that their effects are just supplementary to those of photoperiod.

It may be noted that increasing concentration of NAA and of MH (up to 500 ppm) hastened flowering. At 5,000 ppm, maleic hydrazide greatly delayed flowering. The relative appearances of the plants in the highest concentrations are shown in figure 1.

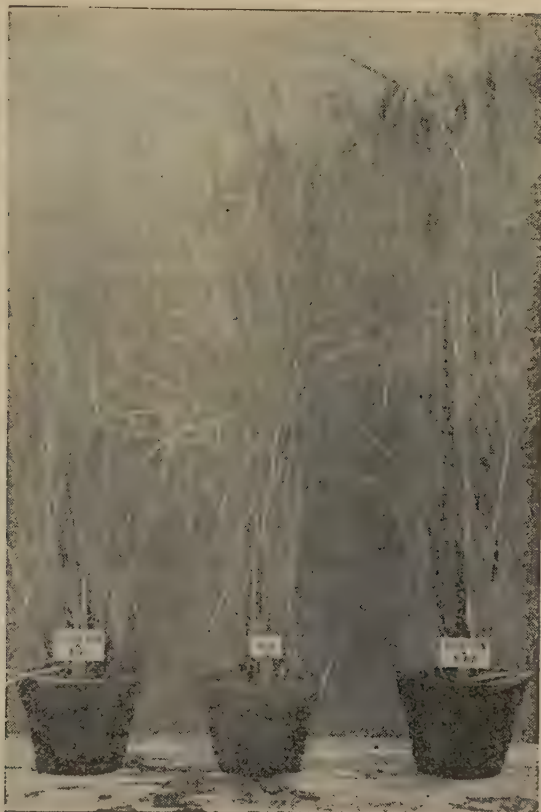


Fig. 1.—From left to right, Elon-elon rice plants sprayed with 5000 ppm MH, unsprayed ones and those that were sprayed with 5000 ppm NAA. Note the stunted appearance of the plants in the 5000 ppm MH-sprayed pot. (Photograph taken by Photographic Division).

Miscellaneous Observations

The receptive leaf. Two approaches were explored in determining the leaf most receptive to the photoperiodic stimulus: (a) selective defoliation before exposing the plant to the short-day cycle, and (b) localized short-day treatment of certain leaves.

The seeds were planted on June 10, 1955. When the plants were 49 days old, lots consisting of five pots each were given the following treatments: lot I, youngest expanded leaf was removed; lots II, III and IV, successively older leaves were cut off. Lot V which was not treated served as the control. All the lots were exposed to a 10-hour photoperiod.

Lot I flowered at 104 days of age, lot II at 86 days and lots III, IV and V at 90 days. Flowering was delayed when the youngest expanded leaf was removed indicating that it is important in photoperiodic perception.

In the second experiment, three lots of 10 plants each were treated as follows: lot I had the youngest two leaves in 12-hour days and the two older leaves in 10-hour days; lot II had the two young leaves in 10-hour days and the older ones in 12-hour days; and lot III had all the leaves in 12-hour days. A dark chamber made of carton with slits on the side for leaves to pass through was used in creating a localized 10-hour day.

Lot I flowered at 161 days of age, lot II at 106 days and lot III at 177 days old. The young leaves in lot II which received the 10-hour photoperiod must have hastened flowering in this lot.

Translocation of the flowering stimulus. It was incidentally observed that when two tillers of the same hill were given a different photoperiod, the tiller receiving the 10-hour photoperiod flowered while the one subjected to the 12-hour photoperiod did not. Apparently the flowering stimulus is not transmitted to a neighboring tiller.

In another instance, the stubble from a crop was allowed to produce new tillers. These young plants flowered in August, although the natural day length was unfavorable for flowering. This indicates that the flowering stimulus can be conserved in the stubble and transferred to the ratoon. The apparent inconsistency is a good subject for speculation. Could it be a case of polarity in the movement of the flowering stimulus such that as long as the tiller which produced the stimulus is using it, there is no transfer to other tillers? Or, could it be a lack of vascular connection between the two tillers?

Effect of continuous illumination. When 45-day-old plants were subjected to continuous illumination, the leaves gradually turned yellow then bright yellowish brown. Yellowing started from the tips and progressed along the margins towards the base. In 48 days

of treatment the change to the bright yellowish-brown condition was completed. It was quite different from nitrogen or sulfur deficiency, but approximated the changes in color when potassium was in excess. The plants eventually died but new tillers continued to grow. Figure 2 was taken when plants were 189 days old. While the untreated lot was ready for harvest, the lot in continuous illumination was still vegetative.



Fig. 2.—Elon-elon rice plants grown under natural day-length conditions (left) and those grown under continuous illumination (right). Picture taken at 189 days old, Nov. 29, 1956. (Photograph taken by Photographic Division).

DISCUSSION

Knowledge gained from studies on *Xanthium pennsylvanicum* has allowed the division of the complex photoperiodic response into:

(a) a high-intensity light process, (b) a dark process, (c) a second high-intensity light process and processes of hormonal translocation and of bud differentiation (Bonner, 1951; Liverman, 1955). The present study may contribute to the elucidation of the dark process which, according to Bonner, is favored by mild temperature and inhibited by applied auxin. Mild temperature was shown in this study to accelerate the flowering process but could not by itself initiate flowering. It is regrettable that facilities for work with a wider range of temperature were not available. A more comprehensive picture of the effects of temperature is desirable. However, other studies (Parker and Borthwick, 1939) have established that low temperature (15°C.) and high temperature (32°C.) are inhibitory to flowering. Optimum temperature for short-day plants is 20 to 25°C. Long (1939) found that the critical dark period is altered with temperature. At 26.5°C., the critical dark period was 8½ hours; at 4.4°C., it was 11 hours. These observations confirm the keen deduction which Garner and Allard (cited by Parker and Borthwick, 1939) made in 1923. "The available evidence seems to indicate that under field conditions at Washington variations from year to year in date of flowering of both early and late varieties of soybeans when planted on any particular date are due chiefly to differences in temperature, while length of day is the primary external factor responsible for the fact that one variety is always relatively early and another late in attaining the reproductive stage."

Another important influence of mild temperature was noted in the threefold increase in grain yield (table 3). Variations in temperature during photoperiodic induction might explain the yearly fluctuations in yield of a variety grown in the same field from year to year and receiving no fertilizer treatment. Adjustment of temperature, therefore, suggests itself as a way of increasing rice yield if large-scale treatment were only practicable. A more detailed study of the effect of mild temperature might lead to discovery of more easily manipulated factors connected with or arising from the treatment. Some aspects worth looking into are the relationships of mild temperature with certain aspects of respiration or with the status of the respirable materials.

The observations on naphthalene acetic acid and maleic hydrazide seem to parallel the observations of Clark and Wittwer (1949) who noticed a hastened seed-stalk elongation with sprays of 2,4-D, orthchloro phenoxypropionic acid, triiodobenzoic acid, NAA and parachloro phenoxypropionic acid. In other words, they found both

auxin-like substances and anti-auxins equally capable of hastening flowering. On the other hand, Bonner (1949) and Bonner and Thurlow (1949) reported inhibition of flowering with indole acetic acid and NAA, and promotion of flowering with 2,4-dichloroanisole, and anti-auxin. If it were assumed that auxin is capable of acting at two points in the chain of reactions to flowering, as Liverman (1955) has suggested, then the parallel promotive effect of auxin and anti-auxin can be reconciled. Auxin can be an inhibitor of the dark process of flowering but an accelerator of bud differentiation. Probably the earliness in flowering caused by the different concentrations of naphthalene acetic acid was a manifestation of its enhancing effect on bud differentiation. On the other hand, the acceleration of flowering by maleic hydrazide up to 500 ppm was probably brought about indirectly by the inactivation of native auxin, hence the acceleration of the dark process.

One difficulty with this explanation is that it takes cognizance of results from only one of two experiments. The inhibiting effect of maleic hydrazide in experiment 1 does not fit into this pattern. A second difficulty is that the sprays in the second experiment were applied long before flower induction and might have set off secondary reactions that have some relations to flowering. The considerations emphasize the fact that the data are not sufficient and the hypothesis should merely stimulate the planning and conducting of more pertinent experiments.

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Education in agriculture is manifestly age old, arising slowly out of experiences and the ancient philosophies concerning the nature of the world and the mysteries of plant and animal life.

—A. R. Mann

* * *

A more fundamental cause of the advancement of agricultural research may be found in a growing faith of the masses in the power of science to solve their problems, and in the well founded belief that this research benefits not only the rural but quite as much the rapidly growing urban population to whom improvement in agriculture offers the best insurance of an adequate supply of food in the face of diminishing supply of virgin agricultural land.

—Eric Englund

CORNCOBS AS PARTIAL REPLACEMENT OF SOILAGE FOR MURRAH HEIFERS ¹

L. S. CASTILLO, L. L. CLAMOHAY, O. A. PALAD, and L. E. NAZARENO ²

Ten Murrah heifers of approximately equal initial weights were assigned at random to either treatment 1, full soilage, or treatment 2, corn-cob ration as partial replacement for the soilage. After a period of 84 days, the treatments were reversed and ran for another 84 days. During the first period, the daily gain in weight of the heifers in treatment 2 was 0.58 kilogram and the heifers in treatment 1 gained 0.62 kilogram. In the second period, the corresponding daily gains were 0.34 and 0.43 kilogram. Differences were not significant. Differences in increment in height and heart girth were likewise not significant but the animals fed on soilage were consistently, though slightly better.

The corncob mixture replaced about 77.6 per cent of the soilage. For short durations corncobs may be used in feeding Murrah heifers without obvious ill effects.

Corncoobs are abundant in regions where corn is grown extensively for human consumption or for feed. However, they are usually burned or thrown out to rot. According to the Department of Agriculture and Natural Resources (1955), the Philippines produced 780,900 tons of shelled corn in 1954 which is 195,225 tons of corncoobs if the shelling percentage is 80 per cent.

Since pasture grass is limited during summer and the labor for gathering soilage is quite expensive, this study was conducted in 1956 to find out if corncoobs can be used to replace a part of the soilage given to Murrah heifers.

MATERIALS AND METHODS

Nine 10-month-old and one 11-month-old Murrah heifers were used. The average weights, heart girths, and heights at the withers of each heifer were taken simultaneously in the morning for three successive days as the initial data. In addition, single measurements were taken every 28 days. The former procedure was followed at

¹ Central Experiment Station Contribution No. 1926. Research Project No. 843. Conducted in the Dairy Husbandry Division of the Department of Animal Husbandry.

² The authors acknowledge the help of Dr. G. W. Trimberger, visiting Cornell professor, in the preparation of this paper, and Messrs. Dominador Aspiras and Jaime Goyena in the care and management of the heifers.

the end of 84 days to get the final data. The differences between the initial and final weights, heart girths, and heights were used as criteria for determining the relative feeding value of corncobs and soilage.

The heifers were divided into two groups of approximately equal initial weights of 178.7 and 180.0 kilograms. Each group was assigned at random to either treatment 1, full soilage, or treatment 2, corncob ration, as partial replacement for the soilage. Two test periods of 84 days each preceded by 14 days of preliminary adjustment to minimize the carry-over effects of the previous treatment were made. The treatments were reversed at the end of the first period. The heifers were placed and fed in individual pens. Remnant of either the corncob mixture or soilage fed was subtracted from the amount given to get the daily individual consumption.

A large amount of soilage was given to each heifer in the control lot to enable the animal to eat as much as it could consume and leave some as refuse. However, in the experimental lot, the amount of soilage given was 25 per cent of the average consumption of the five heifers in the control lot of the previous day. Complete replacement of the soilage with the corncob mixture was not made because vitamin A and D supplements were not included in the corncob mixture.

To enable the heifers in the experimental lot to eat more of the ground corncobs, the concentrate and corncob mixtures were fed together in ratios of 1:1 or 1:2 depending on the individuality of the heifer. Later in the morning, some more corncob mixture was given to the experimental heifers.

The two mixtures were given in the following proportions:

<i>Concentrate</i>		<i>Corncob</i>	
Copra meal	40 kg.	Ground corncobs	75 kg.
Fine rice bran	40 "	Cane molasses	15 "
Ground yellow corn ..	18 "	Copra meal	10 "
Mineral mixture	1 "		
Salt	1 "		

The corncobs were ground twice in a hammer mill with about 1/2 inch clearance in the second grinding. Copra meal was added to increase the protein content of the mixture while molasses was in-

cluded to increase the palatability of the mixture and serve as additional source of energy. The proximate analysis of the concentrate and corncob mixtures³ was as follows:

	<i>Crude Protein</i>	<i>Crude Fat</i>	<i>NFE</i>	<i>Crude Fiber</i>	<i>Ash</i>
Concentrate	14.36	8.86	54.23	5.75	8.53
Corncob mixture	5.74	1.82	60.91	24.71	4.74

RESULTS AND DISCUSSION

Live weights. In the first comparison period of 84 days, the gain in weight of the heifers in the corncob lot was 48.9 kilograms and in the soilage lot, 51.9 kilograms (table 1). The corresponding daily gains in weight in both lots were 0.58 and 0.62 kilogram respectively. In the second period the corncob lot gained 28.7 kilograms and the soilage lot, 36.0 kilograms. The corresponding daily gains were 0.34 and 0.43 kilogram. In both periods, the soilage heifers had higher daily gains than those fed with corncob mixture although the analysis of variance of the individual gains in weight in both treatments for two periods was not significant. These higher daily gains might have been due to the fact that the total amount of feed consumed by the soilage lot contained more nutrients than the total feed consumed by the corncob lot.

TABLE 1.—Average weights (kgm.), heights and heart girth (cm.) of Murrah heifers fed with corncob and soilage

CRITERION	COMPARISON PERIOD	CORNCOB			SOILAGE		
		Initial	Final	Gain	Initial	Final	Gain
Weight	1	180.0	228.9	48.9	178.7	230.6	51.9
	2	229.4	258.1	28.7	228.3	264.3	36.0
Height	1	103.8	108.6	4.8	106.3	111.0	4.7
	2	112.1	115.4	3.3	109.9	113.0	3.1
Heart girth	1	131.4	139.7	8.3	132.5	143.1	10.6
	2	144.3	158.0	13.7	141.8	153.6	11.8

The daily gains in weight may be considered above normal if compared with the data obtained in 1947-1956 from the College dairy herd of grade Murrah heifers which showed daily gains of 0.35 and

³ Analyzed by Misses L. Austria and E. Cruz in the Analytical Laboratory of the Central Experiment Station.

0.29 kilogram corresponding to the two periods in this study. The grade Murrah heifers weighed 163.7 kilograms at 12 months old. The heifers in this study averaged 215.6 kilograms at the same age. The lower rate of growth in the second period (the heifers were 16-1/2 months old at the end of the experiment) is corroborated by Castillo *et al.* (1956) who reported that in the Holstein, Red Sindhi and their crossbreds, the rate of growth dropped from the second to the fifth year.

Height and heart girth. The heifers fed with the corncob mixture grew as fast as those fed with soilage either in height or in heart girth. The gain in height of the corncob lot of 4.8 centimeters and of the soilage lot of 4.7 centimeters in the first period were almost the same. Similar results of 3.3 and 3.1 centimeters for both lots in the second period were obtained. The gain in height during the first period was higher than that in the second. This was followed by a similar trend of decreasing gains in weight as the animals grew older. The analysis of variance of the individual gains in height in both lots for two periods was not significant.

The gain in heart girth of the corncob lot of 8.3 centimeters was less than that of the soilage lot of 10.6 centimeters in the first period. However, in the second period the corncob lot had 13.7 centimeters while the soilage lot had 11.8 centimeters. The analysis of variance of the individual gains in heart girth in both lots for two periods was not significant.

Feed consumption. The average amount of feed consumed daily in the first period by the heifers fed corncobs was 6.8 kilograms and the heifers fed on a full ration of soilage, 11.5 kilograms (table 2). In the second period, the average feed consumption of the corncob heifers was 8.2 kilograms and for the soilage heifers, 17.0 kilograms. The concentrate mixture fed was limited to two kilograms daily for each heifer in both lots and periods. The heifers in the corncob lot

TABLE 2.—Average daily feed consumption per heifer, in kilograms

COMPARISON PERIOD	CORNCOB					SOILAGE			
	Weight	Concentrates	Corncob mixture	Soilage	Total	Weight	Concentrates	Soilage	Total
1	204.5	2.0	2.6	2.2	6.8	204.7	2.0	9.5	11.5
2	243.8	2.0	2.9	3.3	8.2	246.3	2.0	15.0	17.0
Total	448.3	4.0	5.5	5.5	15.0	451.0	4.0	24.5	28.5

actually consumed 0.65 and 0.73 kilogram more of concentrates daily from the molasses and copra meal added to the ground corncob in the first and second periods, respectively.

There was only 0.3 kilogram increase in the consumption of the corncob mixture in the second period over that of the first. However, the soilage consumed by the corncob lot increased by 1.1 kilograms. In both periods, the heifers in the experimental lot consumed 55.1 per cent less roughage (corncob mixture and soilage) than those of the control lot to produce as much gain. This observation corroborates Snapp (1951) who reported that ground corncobs reduced the roughage consumption of yearlings and two-year old steers by about 50 per cent. The corncob mixture replaced about 77.6 per cent of the soilage that was supposed to be fed for normal growth. This tends to show that the corncob mixture furnished a large amount of energy for growth which confirms the report of Burroughs *et al.* (1945) that corncobs can be utilized to supply parts of the digestible nutrients.

The workers did not plan to feed only one kind of soilage during the experiment much less to feed soilage of one stage of maturity. The kind of soilage fed was the one available during the day. During the experiment, however, the bulk of the soilage fed to the heifers was composed of para grass (*Panicum purpurascens* Raddi.) and Alabang X (*Andropogon nodosus* [Willem.] Nash) of medium to mature stage of growth. When these two grasses were not available, mixtures of centrosema (*Centrosema pubescens* Benth.), calopogonium (*Calopogonium muconoides* Desv.), culape (*Paspalum conjugatum* Berg.), and cogon (*Imperata cylindrica* Linn.) were given to the heifers.

The digestible protein and total digestible nutrients of the concentrate and corncob mixtures were estimated using data from Morrison (1948) on the assumption that sheep, cattle, and carabaos might give the same digestion coefficients for the feeds. Since the para grass fed included those from the medium to the mature stage, the digestible protein and total digestible nutrients were estimated from the data obtained by Loosli *et al.* (1954). Similarly the nutrients from Alabang X were estimated from Soliven's⁴ data for the

⁴ Soliven, M. A. "A study of the digestibility of *Andropogon nodosus* (Willem.) Nash." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture for the College of Agriculture, 1955. Unpublished.)

medium and mature stages of growth. The calculated nutrients from one kilogram of each feed given were as follows:

	D.P.	T.D.N.
Concentrate mixture	0.12	0.72
Corn cob mixture	0.02	0.50
Para grass	0.01	0.10
Alabang X	0.01	0.41

These figures show that the total digestible nutrients from Alabang X is about four times that of para grass. On the other hand the corn cob mixture is richer in digestible protein and total digestible nutrients than either of the two kinds of soilage per unit weight.

SUMMARY

1. Ten Murrah heifers divided into two groups of approximately equal initial weights were used in this study for two 84-day periods. Each group was randomly assigned to either the group fed soilage (control) or corn cob group fed a corn cob mixture as partial replacement for the soilage.

2. During the first comparison period, the average total gain in weight of the experimental lot was 48.9 kilograms and the control lot, 51.9 kilograms. The daily gains in weight for both lots were 0.58 and 0.62 kilogram, respectively. During the second period, the corresponding average total gains in weight were 28.7 and 36.0 kilograms while the daily gains were 0.34 and 0.43 kilogram, respectively. There were no significant differences between the gains in weight in both lots for the two periods.

3. The gains in height of the corn cob lot of 4.8 centimeters and 4.7 centimeters for the soilage lot in the first period were almost the same. Similar results of 3.3 and 3.1 centimeters for both lots were obtained in the second period.

4. The average increase in heart girth of the heifers fed the corn cob mixture and those fed fully with soilage were 8.3 and 10.6 centimeters, respectively, during the first period. In the second period the corresponding gains were 13.7 and 11.8 centimeters. These increases in heart girth were not statistically significant for the two periods.

5. The average daily feed consumption for the heifers fed the corn cob mixture plus some soilage was 6.8 kilograms compared to

11.5 kilograms for the heifers fed fully with soilage. During the second period the average daily consumption was 8.2 and 17.0 kilograms, respectively. When both were combined, the heifers on the experimental corncob mixture consumed 55.1 per cent less roughage than the heifers fed fully with soilage. The corncob mixture replaced about 77.6 per cent of the soilage calculated as necessary for normal growth.

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HEMATOCYST IN THE BRAIN OF A BULL¹

G. V. GARCIA AND E. M. RIGOR

WITH ONE TEXT FIGURE

Abscesses of the brain due to invasion of *Actinomyces necrophorus*,² neoplasms and trauma³ are a few of the causes of intracranial pressure. Circulatory disturbances such as thrombosis and embolism involving the brain do not appear to be as common in animals as in man.⁴

This paper is a report on a case of hematocyst in a bull's brain from the onset of symptoms of the disease until the bull was butchered for meat.

HISTORY

This yearling bull together with another bull and a heifer were all kept in an enclosure. The two bulls often butted each other as young animals are wont to do but no serious injuries were inflicted on either except for some bruises.

However, following an encounter one morning, this bull fell with its left horn forcibly striking the cement floor. Before it could recover it was butted again and this time the right horn struck the floor. In the afternoon of the same day the animal appeared visibly sick and was isolated for treatment.

SYMPTOMS

Except for nervous seizures, no gross physical symptoms were observed. A typical nervous seizure started with preliminary circling movements after which the bull would keel over on its hind legs. At other times, the animal would tilt its neck as low as it could and later on fell on its sides. Each seizure lasted for a few minutes and was repeated after a pause. During the early stages of the seizures, the patient appeared to recover its normal stage rather fast after each attack; during the later stages, however, recovery took longer, and the animal appeared somewhat dazed and uncoordinated after an attack. Before each convulsive attack the eyes would be in a fixed stare, followed later by a rotation of the eyeballs. All seizures observed were accompanied by these characteristic movements of the eyeballs. The pulse, temperature and

¹ Central Experiment Station Contribution No. 1927.

² Prchal, C. J. *Jour. of the Am. Vet. Med. Assn.* 128, 79-80 (1953).

³ McGrath, J. T. *Jour. of the Am. Vet. Med. Assn.* 51, 239-241 (1956).

⁴ Runnels, R. A., "Animal Pathology," Collegiate Press, Inc., Ames, Iowa, 1938.

respiration were unaffected. There was partial anorexia. The patient appeared bright and alert after a seizure and while it was under treatment.

TREATMENT

Treatment was mainly symptomatic. Calcium borogluconate (intravenous), 5% dextrose saline solution (subcutaneous) and terramycin (intramuscular) were all tried but no sign of recovery was observed.

LESIONS

Extent of the hematocyst found at the base of the brain was about 3 mm. thick and apparently resulted from rupture of the choroid plexus of the 4th ventricle (table 1). The blood clot extended from the optic chiasm bounded laterally by the pisiform lobes to the root of the accessory cranial nerve. The areas affected included the cerebral peduncles, interpeduncular fossa, pons and lower part of the medulla oblongata as well as its dorsal part just behind the cerebellum. The body and visceral lymph glands were normal.

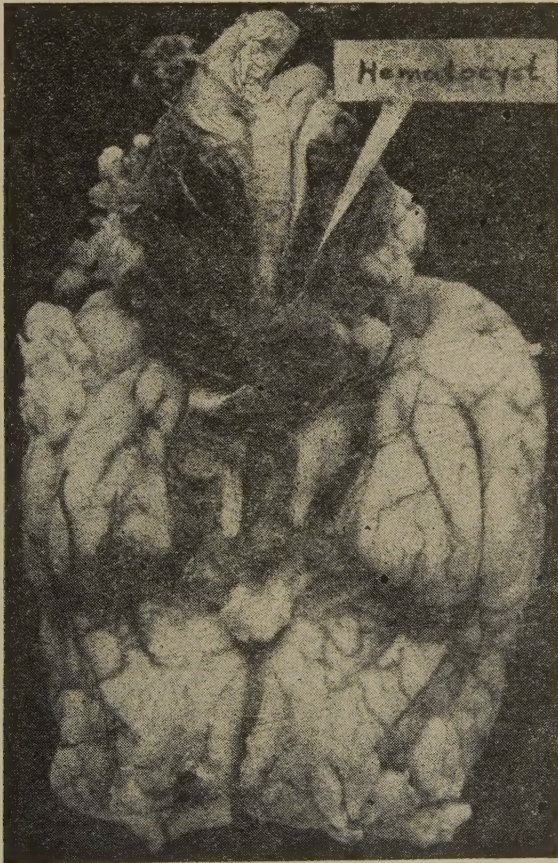


Fig. 1.—Brain-hematocyst

BODY TEMPERATURE, HEAT TOLERANCE, PULSE AND
RESPIRATION RATES OF SANTA GERTRUDIS
CATTLE ON THEIR SECOND YEAR'S
STAY IN THE PHILIPPINES¹

The present study which is a continuation of the work of Manresa Jr. *et al.* (1955) corroborates their finding that the Santa Gertrudis breed of cattle can be adapted to Philippine climate and system of farming.

Average body temperatures in the 3-month cool period was 38.9 ± 0.067 and in the 3-day heat test $38.9 \pm 0.051^{\circ}\text{C}$. A heat tolerance index of 90 was obtained when 14 cows were subjected to a 3-day Iberia heat tolerance test during their second year's stay in Canlubang. The mean pulse rate in the early mornings for the 3-month period was 61.8 ± 0.546 and 63.7 ± 0.489 during the 3-day heat tolerance test. Mean respiration rates of 34.2 ± 1.870 and 29.6 ± 1.657 were obtained during the 3-month period and 3-day heat test, respectively.

The 14 three-year-old cows made an average daily gain of 1.10 ± 0.422 pounds. Eleven cows calved to give a reproductive efficiency of about 80%.

—JOSEPH C. MADAMBA, ANTONIO S. ACHACOSO
and GONZALO V. GARCIA

¹ The authors gratefully acknowledge the help of Mr. Luis A. Yulo of the Canlubang Sugar Estate whose animals and facilities were used in this study.

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